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"SPEAKING" WITH DOLPHINS: DEC Deciphers The Dialogue

The Power And The Glory Of DEC's Pro 380

SPECIAL DEXPO West Preview

The Interspecies Connection

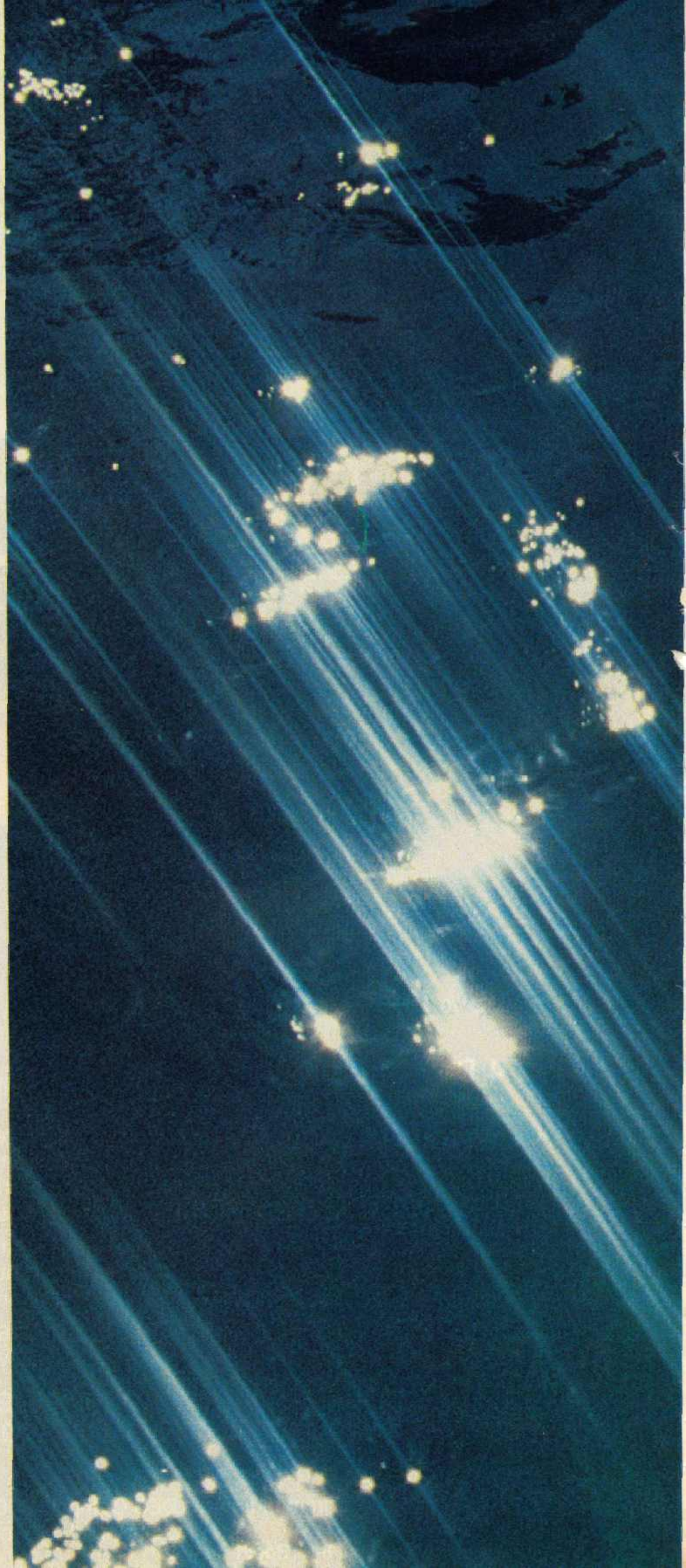
A PDP-based system is bridging the communication gap between man and dolphins, ancient "humans of the sea"

by Leslie Baer-Frohoff

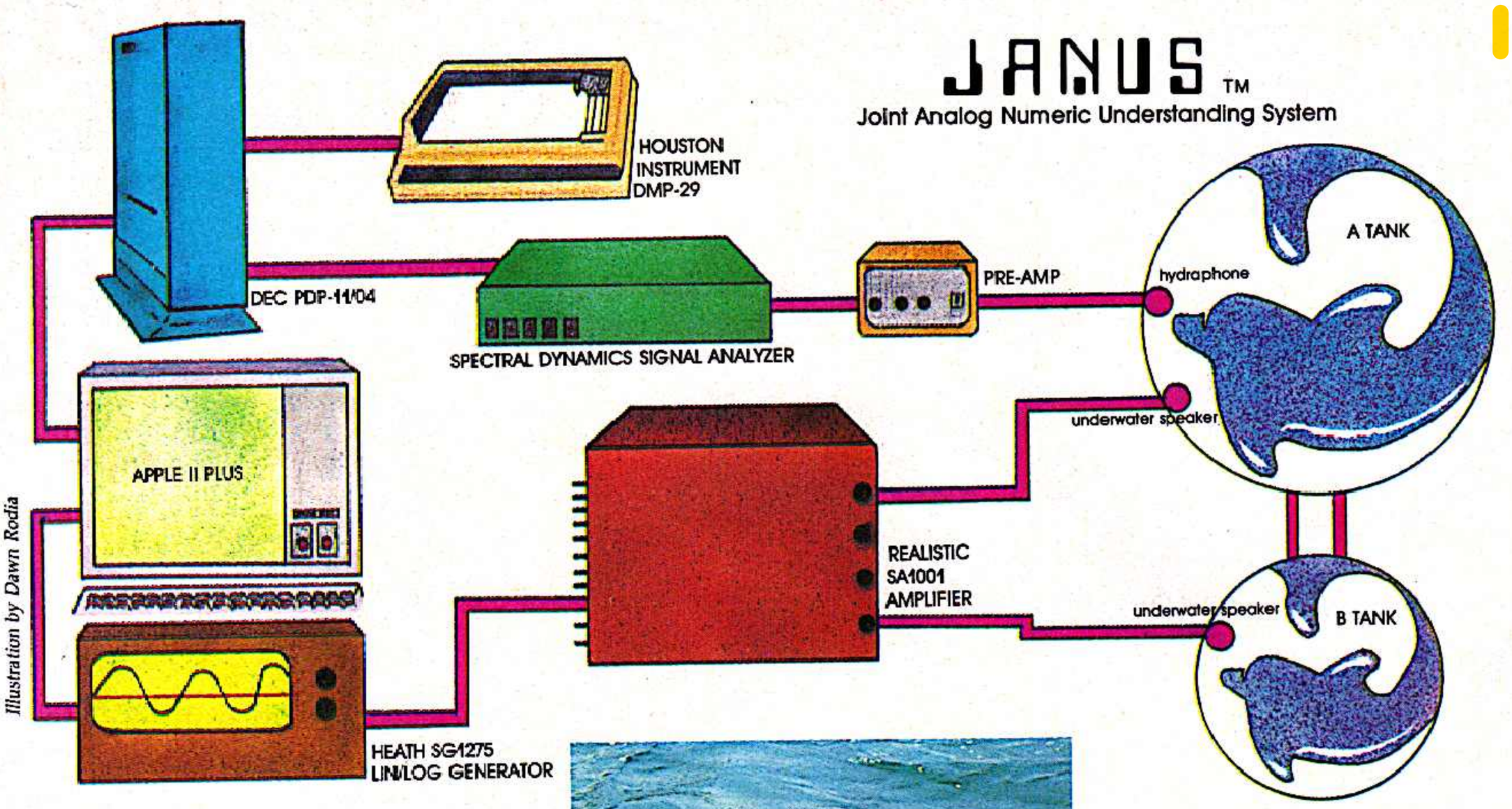
For centuries men have marvelled at *Delphinus,* the dolphin. His name is from the Greek word *delphys,* meaning "womb," although his history on planet earth precedes the dawn of man by some 35 million years. Aristotle wrote books and essays about the dolphin, "the air-breather that nurses its young... has lungs, a gullet and a voice." For the dolphin, the Greeks named the constellation Delphys; and Delphi, home of their sacred oracle of wisdom and the city they called the center of the world.

Throughout recorded history, wild dolphins have been observed seeking human interaction, tantalizing ocean-goers with their energetic acrobatics and playing with ocean-swimming children. The dolphin's regard for human life is evident: Dolphins have been observed shielding human beings from shark attacks and towing drowning swimmers to safety; no dolphin attack on man has ever been reported. While our recorded interaction dates back more than two millennia, our relationship with the water mammal named for the seat of new life remains a mystery.

Photography by James B. Frohoff



"Sometimes I feel that if man could become more involved in some problems of an alien species, he may become less involved with his own egocentric pursuits and deadly competition within his species, and become somehow a better being." — John Lilly



Toward A Fluid Dialogue — *Designed by the Human/Dolphin Foundation, JANUS allows researchers and educated dolphins Joe and Rosie (right) to send and receive whistle-coded communiqués.*

Researchers at the Human/Dolphin Foundation (HDF), in Malibu, Calif., are pursuing the challenge of unraveling that mystery through efforts to make it possible for humans and dolphins to communicate with each other. One of their tools is computer-based JANUS, the Joint Analog Numeric Understanding System. Named for the double-faced Roman god of doors, gateways and beginnings, the specialized PDP-powered system provides a human/dolphin common language.

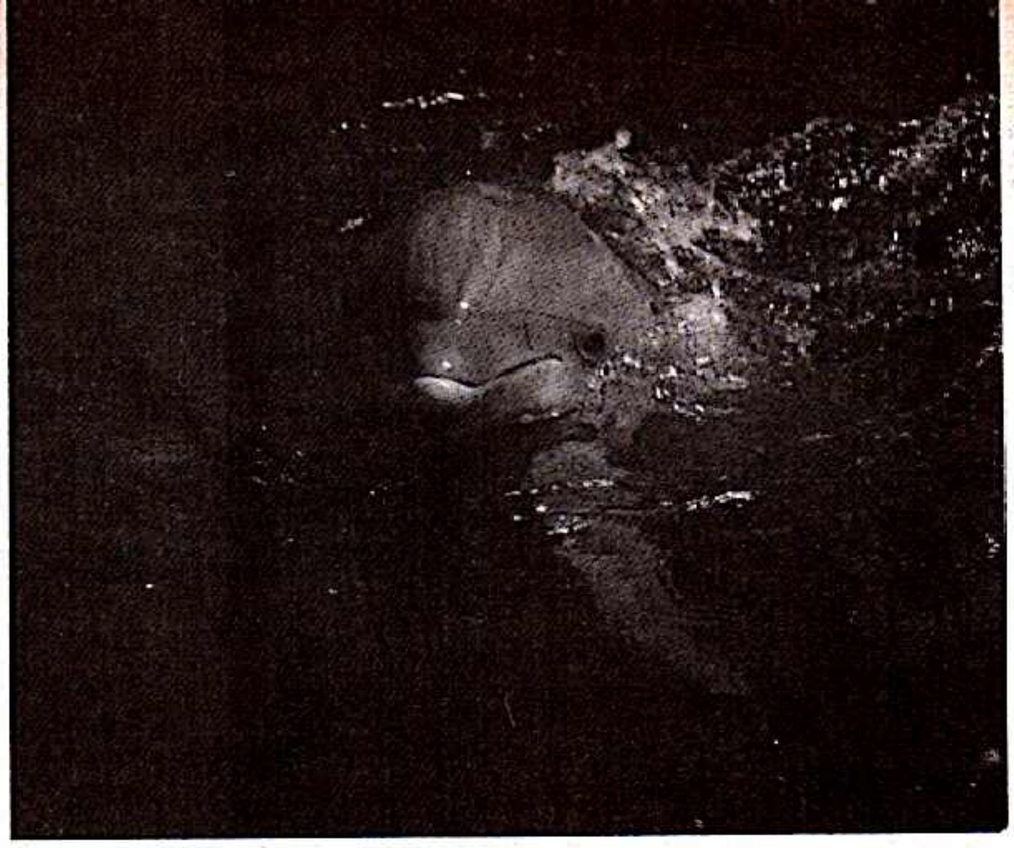
Through JANUS, both man and dolphin speak by means of meaning-assigned whistles. The computer generates the human end of the conversation from keyboard input, and the dolphins learn to understand and send the whistles. The computer then deciphers the dolphin-sent JANUS language whistles and displays the messages on a CRT. JANUS is one of three communication projects ongoing at HDF.

The Foundation was established in 1976 by John Cunningham Lilly, M.D., his wife, cetacean specialist Antonietta, actor Burgess Meredith, and entrepreneur Victor di Suvero. The findings of Lilly, a neurophysicist, have shaped fields across the scientific spectrum and have yielded unprecedented insights into the workings of the human brain and the language and intelligence of dolphins and whales. At age 69, the man who has been called the father of modern dolphin research has entrusted continuation of that work to the enthusiastic HDF team. "I'm just a figurehead now," Lilly says. "I'm officially retired."

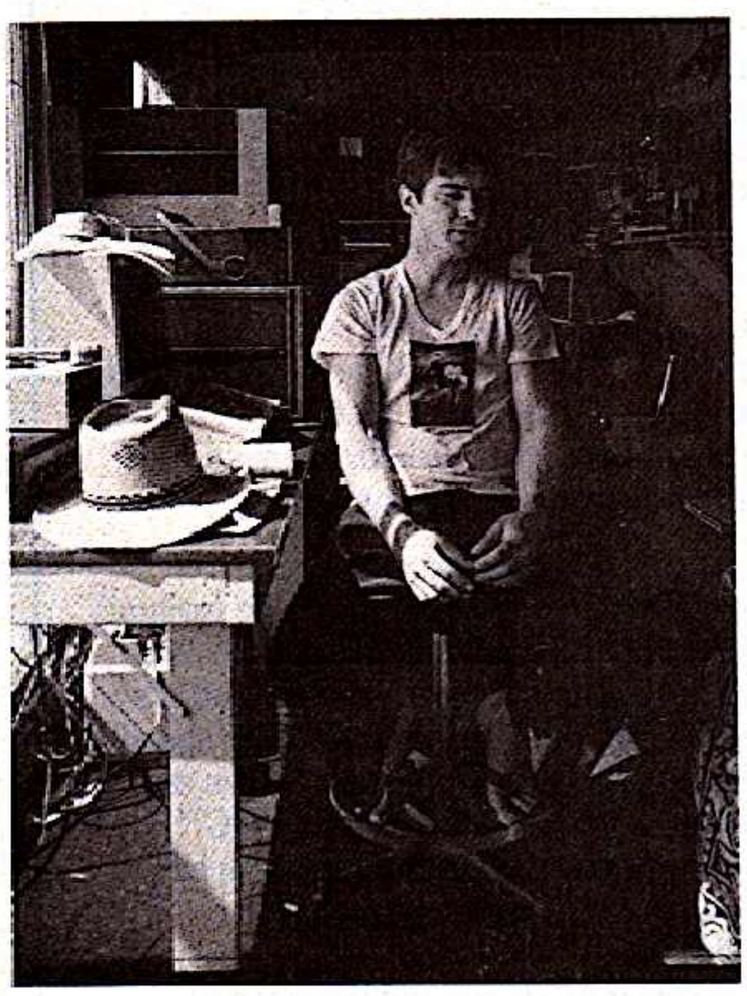
As HDF's consulting Administrator of Research, the seasoned scientist is imparting to his crew a legacy of know-how gleaned from four decades of career work spanning the body and mind. In the 1960s, Lilly's Communications Research Institute (CRI) team made startling discoveries that provided the springboard for the 1973 Avco-Embassy movie, *The Day of the Dolphin* (based on Robert Merle's book of the same name, flagged 'science fiction.') In real life, CRI researchers discovered that dolphins, with their human-sized brains, are highly intelligent; they can think and reason — quite possibly on a level comparable to that of humans — and can be taught to speak English.

In the film, starring George C. Scott, the powers that be see the implications of such a find and try to seize both the project facility and dolphins Alpha and Beta (nicknamed "Fa" and "Be") for military purposes. In an unhappy ending, Scott's research team is forced to flee their island home. In a heart-rending scene, Scott tries to convince the dolphins to escape to the open sea by telling them he doesn't love them anymore and that they must go far away and never speak the human language again. Scott and his wife (Trish Van Devere) leave the area by way of the beach, paced by Fa and Be offshore calling mournfully after them.

Dolphins are already being used in military operations. In an article that appeared in the Oceanic Society's *Oceans* magazine, a Navy-employed dolphin trainer talks about various behaviors taught to Navy dolphins. Those behaviors include dumping loads of explosives at marked sites, killing "enemy" swimmers with knives attached to their flippers and snouts, ripping away air hoses and face masks to drown swimmers and injecting swimmers with paralytic and lethal poisons. But this is not the future HDF researchers have in mind for the dolphin. In the 1950s and 60s, Lilly himself conducted dolphin re-



Making Waves — *Taras Kiceniuk (below) speaks out against enslaving marine mammals like inquisitive Rosie (right). Technician Russ Hockins (seated, lower right) and Head Tech. Ed Ellsworth conduct a JANUS session: "We're moving from 'control' toward understanding." — Ed*



search for the Navy and halted it when he learned of its intended use. That marked the beginning of his perpetual funding woes. The fight for funds is carried on today by HDF's largely volunteer force. Through those efforts, the Foundation has managed to remain autonomous, subsisting on private donations and the earnings of educational projects they sponsor.

"We're not out to have a master-slave rapport with dolphins," emphasizes Taras Kiceniuk, HDF assistant administrator of research. "We're not even out to *train* dolphins." Based on the dolphin intelligence findings made by CRI under the direction of Lilly, HDF is pursuing a truly interactive human/dolphin communications link aimed at one day being able to exchange not only words and short phrases, but "thoughts, ideas and entire philosophies of life", Kiceniuk says. "Our ultimate goal is true interaction on an equal basis — we want to be able to communicate ideas that will be mutually beneficial to our races." It is toward that end, he says, that JANUS is being employed.

Dialogue From The Deep

Before computers were powerful enough to accommodate the needs of HDF researchers, two-way communication with dolphins was enormously difficult. Dolphins naturally do a lot of their vocalizing in frequencies up to 10 times higher than humans are capable of hearing; when they do vocalize in our hearing range, they do so under water where we can hardly hear the sounds anyway. Besides, once we *can* hear dolphin whistles and clicks, how do we decipher them?

An early solution to all three of these problems devised by Lilly's CRI staff was to teach dolphins to vocalize above water and in English. However, teaching dolphins this type of vocalization proved to be difficult. Dolphins have no lips for articulating consonant sounds. Then there's the problem of dolphins slipping under water to utter English (as Peter, one of CRI's first observed dolphins liked to do). The airborne "Flipper talk" heard from dolphin entertainers is a learned behavior. Wild dolphins do their vocalizing under water.

"*Delphinese* appears to be a very highly sophisticated language of 'pictures,'" explains Ed Ellsworth, JANUS technical director. "The dolphins send out high frequency echo location clicks. They get echoes back, and it appears that they use those echoes to assemble a three dimensional acoustic or *holosonic* picture — like an underwater hologram." With their underwater picture language, says Ellsworth dolphins can carry on multiple conversations at distances of two miles or more.

"Let's say one dolphin locates a school of smelt," he continues. "We think that that particular dolphin goes to other dolphins and repeats the same echo sounds it received back from the school of smelt to describe in detail, and in three dimensions, just what it located and where." With current research, the Foundation is not concentrating on code-breaking, although that is one of their long-range goals. "What we're trying to learn from dolphins is how they use their human-sized brains to accomplish all that they do. What we're finding is that dolphins are superb signal processors — better than any human-devised hardware we have going at present." Ellsworth says the best solution would be for dolphins to *tell* human researchers their signal processing secrets. So for now, communication is the focus. "One step at a time," he says, "and JANUS is the first."

Daily JANUS sessions are conducted by Roberta Quist, the Foundation's curator responsible for the dolphins' care and well-being. Ellsworth heads the technical support and JANUS system operation with the assistance of electronics and communications expert Russ Hockins and software specialists Mark Wine and Brad Cotell. Stephen Davies, Brad Stanback and Cindi Kielas, who are cetacean enthusiasts studying at the Foundation through a Work Scholar Program run by Quist, also assist in the sessions. And a session would not be complete, of course, without the Foundation's star Delphinidae family members, Joe and Rosie (named for *The Day of the Dolphin* producer Joseph E. Levine and his wife, Rosalie). The two *Tursiops Truncatus* variety dolphins have been with HDF for four years. They were transported to the Foundation's Marineworld Africa/U.S.A. facility in Redwood City, Calif., from the warm waters of the Gulf of Mexico — the place to which

they returned in late September by virtue of a grant from a German benefactor. HDF research operations have since moved to the Flipper's Dolphin Research Center on Florida's Gold Coast where JANUS work continues.

During teaching sessions, Quist and the JANUS operator team up to cue the dolphins. Early in the project, hand signals for desired behaviors were developed. These hand signals are given by Quist in conjunction with the corresponding computer-generated whistles when the dolphins are learning new behaviors. "It helps the dolphins build a strong association between the whistle and the behavior," she explains. "Sashimi" snacks and human interaction — the dolphins' favorite treats — are given freely as further encouragement.

The JANUS operator accesses the system with an Apple II Plus microcomputer used as the system controller. Keys on the Apple keyboard have been assigned various tones which are the JANUS language words for particular actions, objects and places. As Quist calls out the behaviors to the operator and gives the matching hand signals to the dolphins, the operator presses the pre-programmed corresponding Apple keys, and *voilà!* Whistle words! The Apple drives a tone generator that in turn sends the selected tone through an amplifier to an underwater speaker and into the dolphins' tank.

"Our initial intent was to find out if dolphins could be taught to understand the assigned meaning of our computer whistles," says Kiceniuk. "If so, we planned to work with them on matching those whistles." Understanding and Matching are parts one and two of the first phase of JANUS.

According to Quist, Joe and Rosie have passed "whistle deciphering" with flying colors. The two now understand a full vocabulary of whistle words and phrases. When the JANUS whistle for "through circle" is sent, Joe and Rosie swim through a floating plastic circle. When "circle" is replaced with "square" or "triangle," the dolphins swim through those props instead. Once the appropriate signals are given, Rosie is like the leaping Carl Lewis of dolphins. She bounds over inner tubes and horizontally-held poles. Both dolphins have "bow" (an upward leap) and "jump touch ball" down pat. Quist confides that "on a good day," Joe and Rosie can ace the session even without hand signals.

Now that the two have mastered whistle listening, vocal-matching exercises have begun. During matching sessions, Joe and Rosie are worked with separately and are prompted to respond to computer-generated whistles with a matching whistle. A hydrophone in the dolphins' tank picks up the computer-created tone and the dolphin version. The two whistles are delivered back to the system's PDP-11-driven Spectral Dynamics high-frequency signal analyzer, plotted on a Houston Instrument DMP-29 (recently donated

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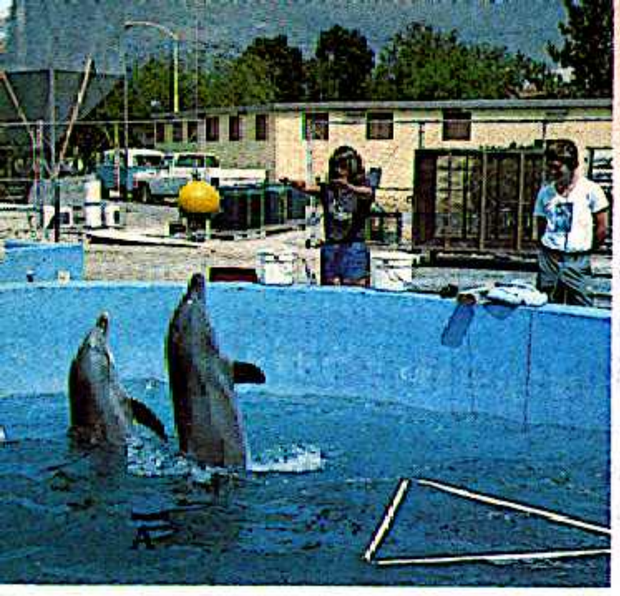
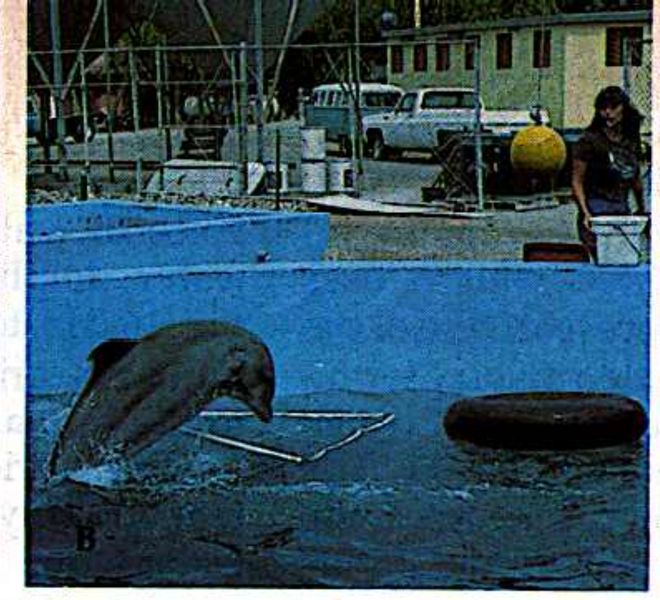
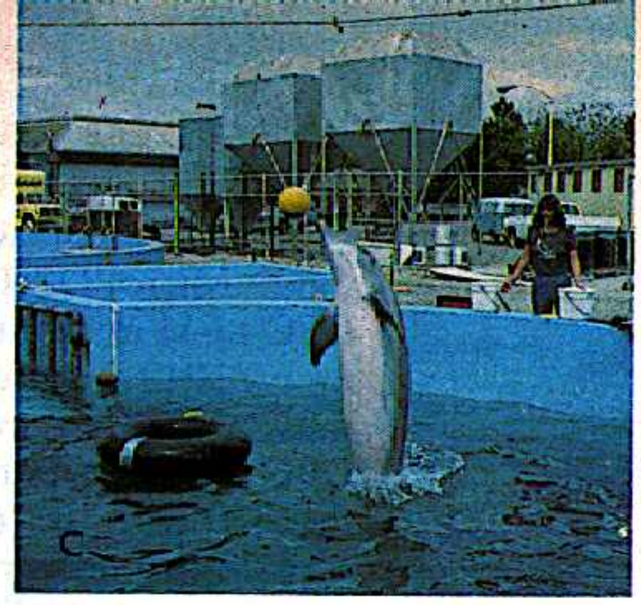
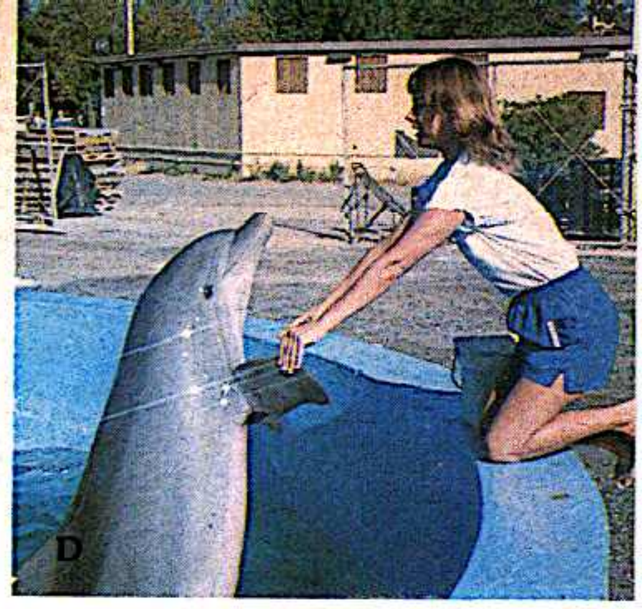


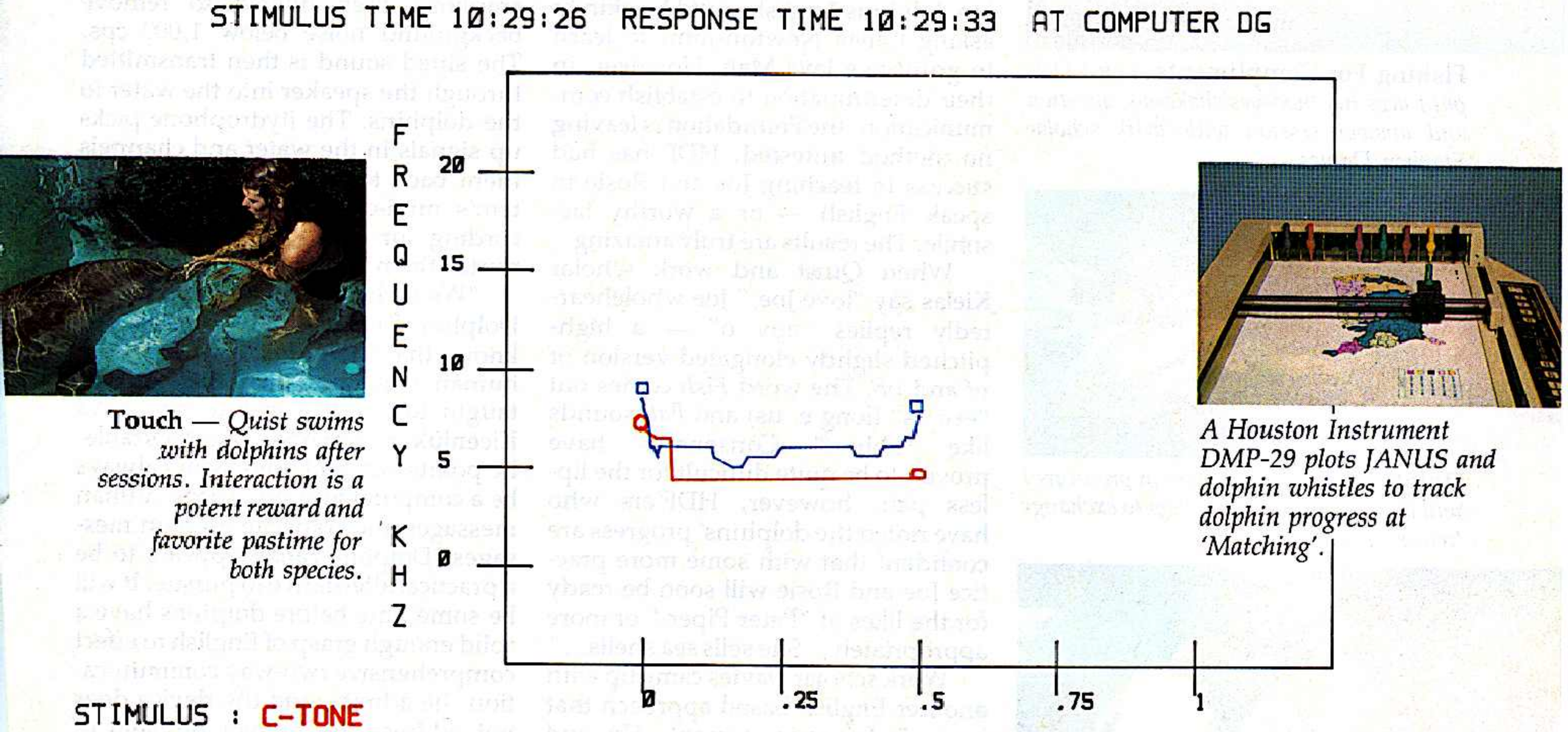






With Baited Breath — *Joe and Rosie dolphins, directed by JANUS whistles and handler Roberta Quist, "tailwalk" (A), dive "through triangle" (B), "jump touch ball" (C), and have "pec (pectoral fin) touch hand" (D) during a teaching session.*

Touch — *Quist swims with dolphins after sessions. Interaction is a potent reward and favorite pastime for both species.*



A Houston Instrument DMP-29 plots JANUS and dolphin whistles to track dolphin progress at 'Matching'.

by the company) then compared. A matching whistle — or a nice try — earns Joe and Rosie the object assigned to the whistle (like an inner tube, ball or fish) as well as loving praise from Quist.

"The results of the matching sessions are encouraging," reports Kiceniuk. "Joe and Rosie are doing very well at matching 'ring,' 'inner tube,' 'fish,' and some unassigned whistles on a regular basis." Kiceniuk predicts the team will wind up Phase I by the end of the year, at which time the dolphins will have an impressive JANUS whistle vocabulary of objects, actions and locations that they can understand and vocalize. Joe and Rosie will need a solid grasp of these skills to move into Phase II, which is, according to Ellsworth, a revolutionary undertaking in the field of interspecies communication.

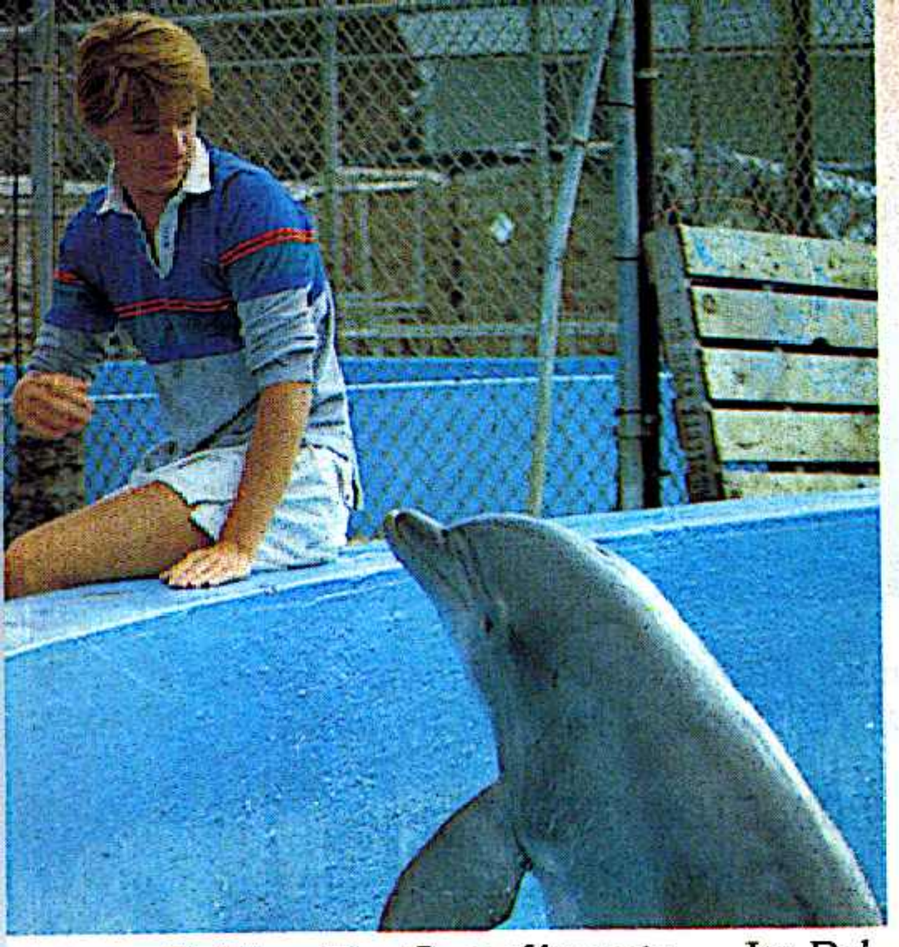
"Phase II will mark the beginning of true interspecies interaction," he declares. "Right now we're limited to asking the dolphins to do certain actions or match a whistle we send. What we're working towards in the next phase is having *them* give *us* signals." The human JANUS team hopes that Joe and Rosie will want to initiate communication, and that when they do, they will make use of the whistle language learned in Phase I.

In Phase II, JANUS will take on the added responsibility of translating dolphin whistles. In this capacity, it will be used essentially in reverse; the frequencies of dolphin whistles will become the unknowns to be analyzed by JANUS and matched to corresponding frequencies in the JANUS database. JANUS-assigned meanings will then be called up and translated dolphin messages output in English to the Apple CRT or as hardcopy on the HI plotter.

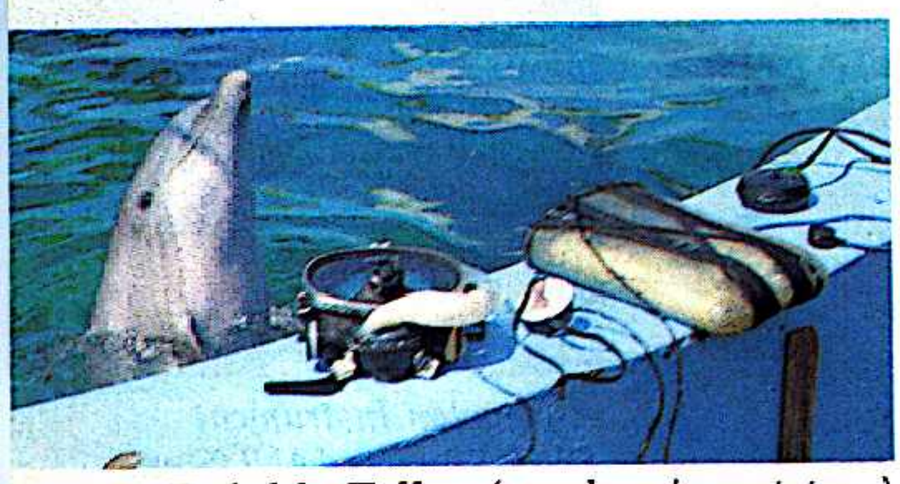
Other possibilities for JANUS are at hand pending an equipment grant currently being considered by DEC. The company has shown an interest in the Foundation and its JANUS research program.

HDF needs to expand the power and flexibility of its data processing equipment and provide for realtime communications between the new Florida site and home base in Malibu.

Plans call for upgrading the



Fishing For Compliments — *Joe Dolphin aces his 'nod-yes/shake-no' question and answer session with work scholar Stephen Davies.*



Dolphin Talker *(seen here in prototype) will allow dolphins and divers to exchange 'words' under water.*

Device Designer *Taras Kiceniuk with diver Allan Therkelsen (above) who tries the Talker for fit and comfort. Kiceniuk (below) dangles the Dolphin Talker hydrophone for a sound check; Rosie Dolphin lazily complies.*

JANUS system with the powerful new MicroPDP-11/73 which uses DEC's J-11 microprocessor, two of the new VT240 series video display terminals, a modem and a Pro 350 which DEC bills as a personal PDP-11. The Pro 350 with its 16-bit processor will replace the slower 8-bit Apple II Plus as system controller.

While JANUS continues at full sail, the Foundation staff is supplementing the project with other efforts. According to Ellsworth, teaching dolphins English could be akin to asking Olivia Newton-John to learn to grunt like Java Man. However, in their determination to establish communication, the Foundation is leaving no method untested. HDF has had success in teaching Joe and Rosie to speak English — or a worthy facsimile. The results are truly amazing.

When Quist and work scholar Kielas say "love Joe," Joe wholeheartedly replies "uuv o" — a high-pitched slightly elongated version of *of* and *oh*. The word *Fish* comes out "eee us" (long e, us) and *Ball* sounds like "ahhw." Consonants have proven to be quite difficult for the lipless pair, however, HDF'ers who have noted the dolphins' progress are confident that with some more practice Joe and Rosie will soon be ready for the likes of "Peter Piper," or more appropriately, "She sells sea shells..."

Work scholar Davies came up with another English-based approach that he is helping implement. He and Quist are teaching Joe and Rosie to nod "yes" or "no" when they are asked questions in English. When a ball is held up and Joe is asked, "Is this a ring?" Joe wags his head side to side, "no." A dangling herring accompanied by the query, "Is this a fish?" elicits a speedy nod "yes" from the dolphins (who both get a tasty sampling). According to Quist, these exercises are helping the dolphins get a better grasp of English. At a later date, this feedback behavior will be used to help assess what the dolphins want and need.

HDF is making the English approach practical with an ingenious electronic device called Dolphin Talker. Developed by Kiceniuk, Dolphin Talker does away with the air-to-water/water-to-air audibility problem by allowing the human who's wearing the device to speak and hear under water. It projects the human voice in water while making underwater dolphin sounds produced in the 16 Hz to 20 kHz spectrum (the human hearing range) clearly audible to the human user.

The device consists of two separate audio systems housed in a single waist-worn module, a microphone, speaker, hydrophone and a set of headphones — all waterproof. The mask-mounted microphone monitors the human voice and inputs it to one of the audio systems where it is amplified then filtered to remove background noise below 1,000 cps. The sifted sound is then transmitted through the speaker into the water to the dolphins. The hydrophone picks up signals in the water and channels them back to the second audio system's mini-cassette recorder for recording or just amplifying, then routes them to the headphones.

"We've headed in the direction of Dolphin Talker simply because we know that dolphins can hear the human voice and that they can be taught to vocalize in English," says Kiceniuk. Since JANUS isn't portable, he points out, and there won't always be a computer around to send human messages and translate dolphin messages, Dolphin Talker appears to be a practical alternative to pursue. It will be some time before dolphins have a solid enough grasp of English to effect comprehensive two-way communication, he admits, and the device does not address the human problem of deciphering Delphinese. However, Kiceniuk feels that with frequent enough interaction and the sincere interest in each other that appears to be present in both species, dolphins and water-bound Dolphin Talker wearers will come to understand each other.

"When I meet someone who speaks a different language, I don't understand very much of what that person is trying to tell me at first," begins Kiceniuk. "But in a setting where we can see and hear each other over a period of time, learn each other's tonal inflections and body language, we can gain an understanding of each other; we can communicate."

Back To Paradise

For Quist, that common understanding — which is not necessarily vocal — is the intent of the Foundation's work. She is head of Project Communion, a hands-on human/dol-

"I observed a school of dolphins...and something told me that here was a creature, all gaiety, charm and intelligence, that might one day come out of the boundless deep and show us how a world can be run by creatures dedicated not to the destruction of their species but to its preservation." — James Thurber

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phin interaction study that is a vital link in the establishment of a seaside interspecies community — HDF's dream come true.

"Through Project Communion, we want to educate interested people of all ages about dolphins, show them that dolphins are sentient beings, intelligent and aware. When I look at a dolphin, I see someone comparable to a human being. I respect them, and I know that they have a lot to give us, if we can just learn to listen." The HDF team hopes that through Communion, man and dolphin will learn the ropes of having interspecies friends — a step toward ensuring the success of the planned seaside community.

Several locations for the community are now being investigated, and support in the form of either funding or expertise will be "eagerly accepted," says Barbara Clark, Malibu operations manager. "There's going to be a lot of room for new ideas to be implemented at our new facility," she says. "We're looking for people who have special skills and for people who just love dolphins."

HDF's research will truly reach fruition when projects like JANUS, Dolphin Talker and Communion enable humans and dolphins of all ages to get their feet (and flukes) wet living together in an aquatic community, complete with waterways and knee-deep flooded quarters. Staff members are anxious to see how pods of wild dolphins will interact with Joe and Rosie, who will be free to come and go as they please, and to bring friends home for dinner as often as they like.

If the idea of talking with dolphins still sounds a little bit fishy to you, simply consider the Darwinian twist: "Our brain has been its current size for about two–tenths of a million years," says Lilly, "while the dolphin's has been that size for 25 million years. I'd like to communicate with these ancient characters to find out just what kind of wisdom they have for us." H